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Changing Tax Elasticities Over Time: The Case of the Ivory Coast

Jane H. Leuthold

College of Commerce and Business Administration
Bureau of Economic and Business Research
University of Illinois, Urbana-Champaign

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Jane H. Leuthold, Professor
Department of Economics

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University of Illinois
Department of Economics
189 Commerce West
1206 S. Sixth Street
Champaign, IL 61820



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ABSTRACT

Tax elasticity, which is a measure of responsiveness of tax revenue to economic growth, is restricted in most studies to be constant over time by the use of a double-log tax function. In the present study, use of a flexible form tax function admits the possibility of fluctuating intertemporal tax elasticities. The model is applied to tax revenue data for a representative developing economy, the Ivory Coast, and intertemporal tax elasticities are estimated for the major Ivorian taxes. The general finding of the study is that tax elasticities in the Ivory Coast are variable over time although some taxes are characterized by constant or near constant elasticities. The results of the study have important policy and research implications.

CHANGING TAX ELASTICITIES OVER TIME:
THE CASE OF THE IVORY COAST

Tax elasticity is a measure of the responsiveness of tax receipts to economic growth. If a tax is elastic, a one percent increase in national income or output results in a greater than one percent increase in revenue from the tax. Since tax receipts may increase for reasons other than economic growth, it is necessary when estimating tax elasticities to control for exogenous influences such as discretionary changes in tax policy.

An elastic tax system is desirable in a developing country because it means that tax receipts will grow automatically with growing income without the need for politically sensitive increases in tax rates.¹ As per capita income increases with economic development, the demand for government goods and services tends to increase. This is particularly the case for goods such as transportation, communication, and general government administration services.² Further, the demand for social services tends to increase with per capita income.³ Add to this increasing government demand for funds to finance development related projects such as education and agricultural extension, and the benefits of an elastic tax system become evident.

An elastic tax system is not without drawbacks, however. Revenue from an elastic tax system tends to be more volatile than revenue from an inelastic tax system. If a tax system is elastic, a one percent decrease in income results in a greater than one percent decrease in tax receipts. Instability of tax revenues can make planning for economic development difficult.

Further, since an elastic tax system is likely to be characterized by high marginal rates, an elastic tax system may distort economic decision-making and generate undesirable excess burdens.⁴ Decisions to work, save and invest may be adversely affected by the high marginal tax rates associated with the elastic tax system. This in turn can lead to large excess burdens since excess burdens increase with the square of the marginal tax rate.⁵

Due to these drawbacks, a balance must be struck between the desire for a revenue responsive tax structure and other development goals. Since the overall elasticity of a tax structure is a weighted average of the elasticities of the taxes that make up that system, the elasticity of the entire tax system can be increased by utilizing more heavily those taxes which are most elastic.⁶ In general, this involves heavy reliance on taxes with high marginal rates.⁷

As development proceeds, the elasticity of the tax system can be expected to change. Tax bases of broad-based income and consumption taxes tend to grow faster than GDP since the taxed sector grows faster than the untaxed subsistence sector leading to increasing intertemporal elasticities.⁸ Likewise, improved tax enforcement and administration may lead to increasing tax elasticities over time as can the use of ad valorem rather than specific taxes.

On the other hand, exemption from taxation of the more elastic bases can lead to reduced tax elasticities. Many countries provide tax investment incentives by exempting certain businesses from taxation for specified periods of time or attempt to help exports with exemptions from export duties.

On balance, it is difficult to predict whether tax elasticities will increase or decrease over time. The purposes of the present study are to test the hypothesis that tax elasticities fluctuate over time in a representative developing country, the Ivory Coast, and to provide estimates of the intertemporal elasticities of the major Ivorian taxes.

Most studies of tax elasticities in developing countries implicitly assume constant tax elasticities over time by their assumption of double-log tax functions of the form:

$$\log T = a_0 + a_1 \log Y \quad (1)$$

where a_1 is the constant tax elasticity, T is tax revenue, and Y is income. Other functional forms for the tax function would admit increasing or declining intertemporal tax elasticities. In this study, a model by Box and Cox (1964) is applied to tax data for the Ivory Coast to determine the appropriate functional form for tax functions in that country.⁹ Following a technique developed by Prest (1962), the data are adjusted to net out the effect of discretionary tax changes on revenue. The general finding of this study is that tax elasticities in the Ivory Coast are variable over time although some taxes are characterized by constant or near constant elasticities. A brief description of taxation in the Ivory Coast follows in Section I. In Section II is a discussion of the methodology used in this study and Section III is a presentation of the results. Section IV is a summary and evaluation.

I. The Tax System in the Ivory Coast

The tax structure in the Ivory Coast is characteristic of that of most developing countries. The composition of the tax structure in

1979 is shown in Table 1. The heavy emphasis on trade and consumption taxes coupled with a lesser reliance on income and property taxes is common in developing countries.

Import duties provide the most important source of revenue in the Ivory Coast. Duties on imports are levied at rates up to 40 percent. The second most important revenue source is the value added tax which is similar in operation to the European value added tax systems but is limited to the manufacturing stage. Foodstuffs are exempt from the tax and rates are graduated over commodity types with a 10 percent rate for quasi-necessities and 20 and 26 percent rates for luxuries. The tax is imposed on the manufacturing sector with credits for taxes paid on inputs, including investment goods. The Ivory Coast also has a turnover tax on services but these firms may opt for the value added tax.¹⁰

The individual income tax in the Ivory Coast is schedular in form. Wages and salaries are subject to four different income taxes. The Ivory Coast follows the French pattern of splitting income among husband, wife and children with the husband and wife each allocated one part and each child one-half part up to a maximum of five parts. Rates are graduated up to 60 percent; however, the maximum effective rate is around 33 percent.¹¹

Corporate income is subject to three taxes, a tax on corporate profits, a national contribution, and a national investment fund whose combined rates are 50 percent. The tax on corporate profits offers a five year exemption for new businesses with prior approval. A 50 percent investment allowance is also granted for investment in the

Table 1 The Composition of the Tax Structure in the Ivory Coast, 1979

	Percent of Revenue	
INCOME TAXATION		15.7
Profits tax	7.2	
Individual income tax	5.1	
Other income taxes	3.3	
CONSUMPTION TAXATION		32.2
Value added taxes	24.1	
Excise taxes	5.3	
Tobacco	1.5	
Alcoholic beverages	.4	
Gasoline	3.4	
Timber	2.8	
PROPERTY TAXES		1.1
Real estate tax	.9	
Motor vehicle tax	.2	
TRADE TAXES		48.9
Import duties	41.0	
Export duties	7.9	
OTHER		2.2
TOTAL		100.1

Source: International Monetary Fund (1984, p. 223).

construction of new buildings or in manufacturing or similar projects.

Other taxes include excise taxes on tobacco, alcoholic beverages, and gasoline, a timber tax, and two property taxes, one on real estate and the other on motor vehicles. Together, these taxes account less than 10 percent of total revenue.

II. Methodology

In order to allow for the possibility of changing tax elasticities over time, a model suggested by Box and Cox (1964) is applied in this study.¹² If T_{it} is revenue from the i th tax in period t and Y_t is gross domestic product in time t , then the model is:

$$T_{it}^{(\lambda)} = \alpha_0 + \alpha_1 Y_{it}^{(\lambda)} + e_{it} \quad (2)$$

where e_{it} is a random disturbance and:

$$T_{it}^{(\lambda)} = \begin{cases} (T_{it}^\lambda - 1)/\lambda & \text{for } \lambda \neq 0 \\ \ln T_{it} & \text{for } \lambda = 0 \end{cases}$$

and:

$$Y_{it}^{(\lambda)} = \begin{cases} (Y_{it}^\lambda - 1)/\lambda & \text{for } \lambda \neq 0 \\ \ln Y_{it} & \text{for } \lambda = 0 \end{cases}$$

If the transformation parameter, λ , equals one, the model takes on the linear form:

$$T_{it} = \alpha_0 + \alpha_1 Y_{it} + e_{it} \quad (3)$$

while if λ equals zero, the model takes on the traditional double-log form:

$$\ln T_{it} = \alpha_0 + \alpha_1 \ln Y_{it} + e_{it} \quad (4)$$

Other values of λ lead to alternative nonlinear tax equations.

The tax elasticities depend on the values of the coefficient of the income variable, α_1 , and on the transformation parameter, λ . For the i th tax, the elasticity is given by:

$$\varepsilon_i = \alpha_1 (Y_{it}/T_{it})^\lambda \quad (5)$$

In the special case when the transformation parameter equals zero and the tax function takes on the double-log form, the elasticity reduces to α_1 and is constant over time. When λ is different from zero, the elasticity depends on the ratio Y_{it}/T_{it} which may vary over time causing intertemporal variation in the elasticity.

The above model was estimated on data for the major Ivorian taxes covering the time period 1970 through 1979.¹³ The data were adjusted to net out the effect of discretionary tax changes following a procedure developed by Prest (1962) in studying the personal income tax in the United Kingdom. The method requires estimates of the effects of discretionary tax changes on the year's tax receipts by type of tax. For this study, these were based on estimates developed by the International Monetary Fund.¹⁴ Adjustment factors were computed for each tax for each year and applied to receipts to obtain receipts net of discretionary tax changes. These data formed the basis for the estimation of this study. The results of the estimation are presented in the next section.

III. Estimation Results

The model described in the previous section was estimated using the SHAZAM statistical package. The results by tax are shown in Table 2. The slopes (α_1 in the model above) were all significantly different from zero at the .99 confidence levels. For all but one of the taxes, the income and profits tax, the transformation parameters were different from zero indicating changing tax elasticities over time. The model fit the data very well according to the adjusted R-squared statistic which measures the goodness of fit.

The elasticities evaluated at the mean for each tax are shown in Table 3. They range from 1.401 for the value added tax to .340 for the export duties. The taxes which are elastic (have elasticities greater than one) are total consumption taxes, the value added tax and import duties. Revenues from these taxes generally grow faster than GDP probably because these taxes are easier to enforce than other taxes. The other taxes are inelastic (have elasticities less than one) with revenues growing slower than income. Besides the export duties, the most inelastic taxes are the excise taxes and, in particular, the gas tax.

For comparison, estimates of the elasticities for each of the taxes based on the double-log model are also shown in Table 3. The double-log elasticities sometimes overestimate and sometimes underestimate the elasticities based on the Box-Cox model. The largest percentage differences are for the gas tax, excise taxes, import duties, and value added taxes. Very little difference between the two models is detected for the profits tax, customs duties, and total income and profits taxes.

Table 2 Estimation Results Using the Box-Cox Transformation, 1970-1979

<u>Tax</u>	<u>Intercept</u>	<u>Slope</u>	<u>Transformation Parameter</u>	<u>Adjusted R²</u>
All taxes	.460	.365**	.61	.997
Income and Profits taxes	-2.429**	.844**	.00	.919
Income Tax	-.515	.011**	1.05	.948
Profits Tax	-2.320**	.559**	.09	.950
Consumption Taxes	-7.758**	.108**	.85	.997
Value Added Taxes	-6.286**	.351**	.43	.993
Excise Taxes	180.960**	.000017**	2.92	.967
Gas Tax	6.710**	.00002**	2.20	.997
Customs Duties	-1.345**	.814**	.04	.993
Import Duties	-56.558**	102.240**	-1.79	.999
Export Duties	37.657**	.0017**	1.41	.832

**Significantly different from zero at the .99 confidence level.

Table 3 Comparison of Elasticities of Ivory Coast Taxes Computed
Using the Box-Cox Transformation and Double Log Function

Tax	Box-Cox	Double-Log	Percentage
	Elasticity (1)	Elasticity (2)	Difference $\frac{(2)-(1)}{(1)} \times 100$
All taxes	.974	.961	-1.33
Income and Profits Taxes	.843	.844	.12
Income Tax	.836	.809	-3.23
Profits Tax	.818	.813	-.61
Consumption Taxes	1.172	1.218	3.92
Value Added Taxes	1.401	1.492	6.50
Excise Taxes	.534	.491	-8.05
Gas Tax	.752	.675	-10.24
Customs Duties	.891	.890	-.11
Import Duties	1.158	1.074	-7.25
Export Duties	.340	.344	1.18

Finally, the elasticities were calculated for each tax for each year of the data. These are shown in Table 4. As can be seen in the Table, the elasticities vary over time, but, in general, not monotonically. However, three taxes have clearly become more elastic over time: excise taxes, the gas tax, and the export duties. The value added taxes, on the other hand, have tended to become less elastic over time while taxes like the income tax show cyclical variation. In total, the elasticity of Ivorian taxes declined in the early seventies, peaked in the mid- and late-seventies.

IV. Conclusions

The results of the study show that over the period of study, the elasticities of Ivorian taxes have varied. A Box-Cox model was estimated for each of the major Ivorian taxes and found to fit the data better than the standard double-log model in almost every case. This result has important implications for the study of tax elasticities in developing economies.

Relying on the double-log model to estimate tax elasticities not only gives mistaken estimates, it also restricts the elasticities to be constant over time. The Box-Cox model does not so restrict the elasticities, and, as shown for the Ivory Coast, this can be important for certain taxes. Basing policy decisions on incorrect elasticities can lead to incorrect policies. Hence, it is important to correctly estimate tax elasticities and their variation over time.

Table 4 Intertemporal Tax Elasticities for the Ivory Coast, 1970-79

<u>Tax</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>
All taxes	.959	.922	.834	.901	1.048	.987	.962	1.063	.989	.987
Income and Profits Taxes	.844	.844	.844	.844	.844	.844	.844	.844	.844	.844
Income Tax	.826	.804	.724	.716	.753	.766	.781	.790	.767	.758
Profits Tax	.812	.807	.799	.798	.815	.821	.828	.831	.821	.817
Consumption Taxes	1.520	1.411	1.304	1.437	1.190	1.162	1.218	1.109	1.084	1.102
Value Added Taxes	1.839	1.727	1.689	1.699	1.509	1.403	1.387	1.389	1.292	1.287
Excise Taxes	.145	.132	.010	.144	.583	.637	1.129	.944	.818	.954
Gas Tax	.393	.385	.292	.386	.918	.815	1.216	.853	.394	.978
Trade Taxes	.887	.887	.887	.887	.892	.891	.888	.892	.893	.893
Import Duties	1.011	1.028	1.039	1.008	1.065	1.043	1.381	1.251	1.159	1.184
Export Duties	.153	.157	.158	.151	.337	.282	.336	.539	.533	.588

The techniques of this study could be readily extended to the study of taxes in other developing economies. As the tax systems of developing economies mature with the introduction of new taxes and the redesign of existing taxes, fluctuating intertemporal elasticities can be expected. If the development policy involves placing more reliance on the more elastic taxes, it is important for policymakers to be able to correctly identify those taxes. Also, since tax elasticities are sometimes used for forecasting expected tax revenues, accurate tax elasticity estimates are essential. For these reasons, the research presented in the present study holds promise for policymakers and researchers alike.

FOOTNOTES

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¹Due (1981 p. 550).

²Lewis (1984 p. 34).

³Ibid., Lewis (1984 p. 34).

⁴By definition, elasticity = $(\partial T/T) \times (\partial Y/Y) = (\partial T/\partial Y)/(T/Y) =$ (marginal tax rate)/(average tax rate) where T is tax receipts and Y is income. If the tax system is elastic, the elasticity is greater than one, and the marginal tax rate exceeds the average tax rate.

⁵A standard formula for the excess burden of a tax is $W = (1/2)E_S E_D t^2 PQ / (E_S + E_D)$ where E_S and E_D are the elasticities of supply and demand, t is the marginal tax rate, and PQ is total expenditures on the taxed good. From this formula, it follows that doubling the marginal tax rate quadruples the excess burden of the tax. See Browning and Browning (1983 pp. 315-317).

⁶The overall elasticity of a tax system is given by $E = (T_1/T) \times E_1 + \dots + (T_n/T) \times E_n$ where T_k/T is the share in total receipts of the k th tax and E_k is the elasticity of the k th tax for $k = 1, \dots, n$. See Mansfield (1972 p. 426) for the derivation.

⁷One exception is the value added tax which, in a developing economy, may be relatively elastic while utilizing low marginal rates. Heavy reliance on the value added tax may, therefore, lead to an elastic tax structure in a developing economy.

⁸Goode (1984 p. 93).

⁹Greytak and Thursby (1979) apply this technique to the New York State income tax and find it to be characterized by a constant elasticity.

¹⁰For a description of the Ivorian value added tax and its operation, see Koffi (1981).

¹¹See Arthur Anderson and Company (1982) for further details.

¹²See Judge, et. al. (1980 pp. 308-311) for a description of the Box-Cox model and its properties.

¹³The data were obtained from International Monetary Fund (1984, Table 1, p. 222). An error in the data resulting in a nine billion CFA understatement of excise taxes, consumption taxes, and total tax receipts in 1977 was corrected.

¹⁴See IMF, 1984 (Table 2, p. 231).

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